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Morphological and kinetic consequences of the scratching of the growing crystal surface

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Crystals growing in real mineral-forming system are often exposed to the mechanical impact, the evidence of which is scratches and cracks. Mineralogist sees it not merely as a destruction process, but as an imprint, which allows to reconstruct one of historical stages of the crystal and its environment. With the appearance of atomic-force microscopy (AFM) methods it became possible to experimentally model the processes and observe the response of a growing crystal to the impact on its surface. Moreover, an AFM tip can also be used as a nanoindenter scratching the growing surface. This fact has been used in works studying the processes on the surface after it being affected by the tip [1, 2]. The purpose of the present work was to do an AFM study of the morphological and kinetic consequences of evolution of a growing and dissolving crystal in the area of an intentional scratch on its surface. Model crystals of hydroxymethylquinoxalindioxyde ($C_{10}H_{10}N_2O_4$) were obtained directly in the liquid cell of the microscopy. Different furrows were drawn on the face (100) of dioxydine crystal by means of AFM probe. The force with which it presses the surface during the contact mode is 10^{-8} N. Friction force of the probe and the specimen in a humid condition is equal to stressing force in the 2/3 degree [3]. In the standard mode, with the feedback being on, this interaction force is constantly maintained and the probe does not touch the surface. When scanning is not working and the feedback is off, the probe can be intentionally moved along the surface. Often it makes the mechanical impact on the growing surface that initiates the pits (Fig. 1). We have established that the occurrence of a defect depends on whether the tip moves on or against the direction of growth steps movement. The influence of such short-term contact has important crystal-genetic (morphological and kinetic) consequences and is perceptible even after a long time.

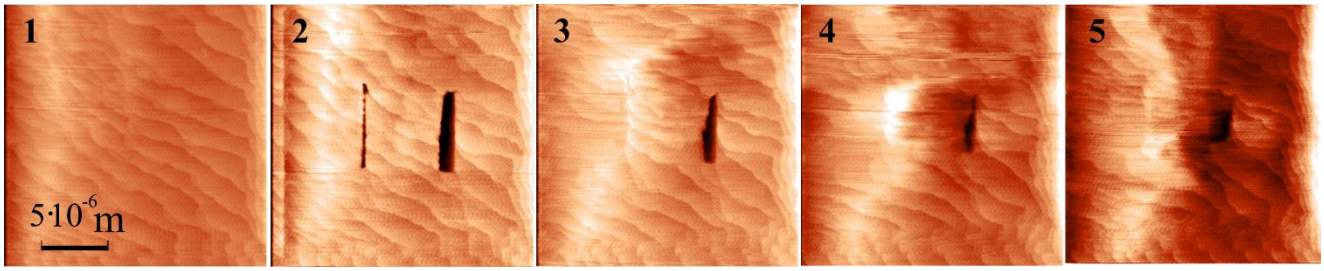

Figure 1. AFM-snapshots of the growing crystal's surface (the part of layer-by-layer growth area) before (1) and after (2-5) being scratched.

We carried out experiments with a mechanical deformation on topographically different parts of a growing crystal. We have studied the difference in the sculpture and the behavior of scratching steps formed by the screw dislocation: near the peak point and far from the peak point (layer-by-layer growth area). This leads to non-linear effects; first, to the loss of morphological stability. We observe the phenomenon of simultaneous growth and dissolution at the neighbouring steps. The tangential velocities of the set of points on the growth steps were calculated with the use of image processing program. The obtained data were subsequently statistically processed. Results were compared with images of the similar spirals growing without a scratch.

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